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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

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(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Segment.based motion estimation

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Segment-based motion estimation

The invention relates to a method of segment-based motion estimation to determine motion vectors for respective segments of a segmented image.

The invention further relates to a motion estimation unit for estimating motion vectors for respective segments of a segmented image.

The invention further relates to an image processing apparatus comprising:

- a segmentation unit for segmenting an input image into a segmented image; and
- such a motion estimation unit for estimating motion vectors for respective segments of the segmented image.

Segment-based motion estimation is an important processing step in a number of video processing algorithms, e.g. 2D into 3D content conversion, video coding, scan rate conversion, tracking of objects for security purposes, and picture quality improvement. Whereas, current motion-estimation algorithms are mostly block-based, segment-based motion estimation has the potential for higher accuracy since motion vectors can be computed pixel-accurate. Given a segmentation of an image, e.g. video frame, a sketch of the segment-based motion estimation is as follows: select candidate motion vectors for each segment, evaluate each of the candidate motion vectors per segment by means of computing respective match errors and select the best matching candidate motion vectors per segment on basis of the evaluation.

Since segments can be of arbitrary shape and size, a straight-forward implementation of this algorithm will result in the inefficient use of the memory bandwidth. Typically, pixel values of a bounding box of the segment under consideration are accessed from memory. This would result in inefficient use of memory bandwidth since not all the pixels within the bounding box are part of the segment under consideration.

It is an object of the invention to provide a method of the kind described in the opening paragraph which is based on a relatively efficient memory bandwidth usage.

This object of the invention is achieved in that the method comprises:

- creating sets of candidate motion vectors for the respective segments;
- dividing the segmented image into a grid of blocks of pixels;
- determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, on basis of the segments and the locations of the blocks within the segmented image;
- computing partial match errors for the blocks on basis of the determined candidate motion vectors and on basis of pixel values of a further image;
- combining the partial match errors into a number of match errors per segment;
- selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors; and
- assigning the selected candidate motion vectors as the motion vectors for the respective segments.

An important aspect of the invention is the overlaying of a grid of blocks on a segmented image and doing an efficient motion estimation per block. After the motion estimations per block have been performed, the results per segment are computed by means of accumulation of the results per block. Hence, memory access and computation of partial match errors are block-based. These features enable an easy implementation of the segment-based motion estimation algorithm. An other advantage of the method according to the invention is that massive parallelism can be achieved, since a segmented image can be split into several groups of blocks, e.g. stripes of blocks: processing the blocks of the various stripes can be done in parallel. This feature can steer numerous parallel solutions (VLIWs, ASICs) for this method.

An embodiment of the method according to the invention further comprises:

- splitting each block of a portion of the blocks into respective groups of pixels on basis of the segments and the locations of the blocks within the segmented image, each block of the portion of the blocks overlapping with multiple segments;
- determining for the groups of pixels which of the candidate motion vectors belong to the groups of pixels, on basis of the segments and the locations of the groups of pixels within the segmented image;

- computing further partial match errors for the groups of pixels on basis of the determined candidate motion vectors and on basis of the pixel values of the further image; and
- combining the partial match errors and the further partial match errors into a number of match errors per segment.

If a block overlaps with multiple segments, then the block is split into a number of groups of pixels, with the number of groups being equal to the number of segments with which the block overlaps. For each of the groups of a block a partial match error is being calculated. That means e.g. that if a block overlaps with four segments, then four groups of pixels are established. For each of the four groups the corresponding candidate motion vectors are evaluated. So, four partial match errors are computed for that block. Eventually these four partial match errors are accumulated with the partial match errors belonging to the respective segments. An advantage of this embodiment according to the invention is the accuracy of the evaluation results.

In another embodiment of the method according to the invention, determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, is based on the amount of overlap between segments and the blocks within the segmented image. In this embodiment according to the invention, the number of evaluated candidate motion vectors for a block is not linear related to the number of overlapping segments. E.g. suppose that a block overlaps with two segments and that for each of these segments there are five candidate motion vectors, then a maximum of ten candidate motion vectors could be evaluated for that block. However, if the amount of overlap with one of the segments is relatively small, e.g. less than 10% of the pixels of the block then evaluation of the candidate motion vectors for that segment could be skipped for that block. That means that only the candidate motion vectors of the other segment, with a relatively large amount of overlap are evaluated: five in this example. For this evaluation two different approaches can be applied. First, the candidate motion vectors are evaluated for all pixels of the block, including the pixels which belong to the other segment. Second, the candidate motion vectors are evaluated for only a group of pixels comprised by the pixels of the block, excluding the pixels which belong to the other segment. An advantage of this embodiment according to the invention is that the number of computations is limited compared with the other embodiment as described above.

In an embodiment of the method according to the invention, a first one of the partial match errors corresponds with the sum of differences between pixel values of the

segmented image and further pixel values of the further image. Preferably the partial match error corresponds to the Sum of Absolute Difference (SAD). With pixel value is meant the luminance value or the color representation. An advantage of this type of match error is that it is robust, while the number of calculations to compute the match error is relatively small.

Preferably a block of pixels comprises 8*8 or 16*16 pixels. This format is a often used format. An advantage is compatibility with off-the-shelf hardware.

It is a further object of the invention to provide a motion estimation unit of the kind described in the opening paragraph which is based on a relatively efficient memory bandwidth usage.

This object of the invention is achieved in that the motion estimation unit comprises:

- creating means for creating sets of candidate motion vectors for the respective segments;
- dividing means for dividing the segmented image into a grid of blocks of pixels;
- determining means for determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, on basis of the segments and the locations of the blocks within the segmented image;
- computing means for computing partial match errors for the blocks on basis of the determined candidate motion vectors and on basis of pixel values of a further image;
- combining means for combining the partial match errors into a number of match errors per segment;
- selecting means for selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors; and
- assigning means for assigning the selected candidate motion vectors as the motion vectors for the respective segments.

It is a further object of the invention to provide an image processing apparatus of the kind described in the opening paragraph comprising a motion estimation unit which is based on a relatively efficient memory bandwidth usage.

This object of the invention is achieved in that the motion estimation unit is arranged to perform the method as claimed in claim 1. An embodiment of the image processing apparatus according to the invention comprises processing means being controlled on basis of the motion vectors. The processing means might support one or more of the following types of image processing:

- Video compression, i.e. encoding or decoding, e.g. according to the MPEG standard.
- De-interlacing: Interlacing is the common video broadcast procedure for transmitting the odd or even numbered image lines alternately. De-interlacing attempts to restore the full vertical resolution, i.e. make odd and even lines available simultaneously for each image;
- Image rate conversion: From a series of original input images a larger series of output images is calculated. Output images are temporally located between two original input images; and
- Temporal noise reduction. This can also involve spatial processing, resulting in spatial-temporal noise reduction.

The image processing apparatus optionally comprises a display device for displaying output images. The image processing apparatus might e.g. be a TV, a set top box, a VCR (Video Cassette Recorder) player, a satellite tuner, a DVD (Digital Versatile Disk) player or recorder.

Modifications of the method and variations thereof may correspond to modifications and variations thereof of the motion estimation unit described.

These and other aspects of the method, of the motion estimation unit and of the image processing apparatus according to the invention will become apparent from and will be elucidated with respect to the implementations and embodiments described hereinafter and with reference to the accompanying drawings, wherein:

Fig. 1 schematically shows two consecutive segmented images;

Fig. 2 schematically shows a detail of Fig. 1;

Fig. 3 schematically shows an embodiment of the motion estimation unit according to the invention; and

Fig. 4 schematically shows an image processing apparatus according to the invention.

Same reference numerals are used to denote similar parts throughout the figures.

Fig. 1 schematically shows two consecutive segmented images 100 and 102. The first image 100 comprises four segments, S11, S12, S13 and S14. The second image 102

also comprises four segments S21, S22, S23 and S24. Segment S11 of the first image 100 corresponds to segment S21 of the second image 102. Segment S12 of the first image 100 corresponds to segment S22 of the second image 102. Segment S13 of the first image 100 corresponds to segment S23 of the second image 102. Segment S14 of the first image 100 corresponds to segment S24 of the second image 102. Because of movement, e.g. movement of the camera related to the objects in a scene being image, the various segments are shifted related to the image coordinate system. These shifts can be estimated by means of motion estimation. That means that motion vectors $MV(1)$, $MV(2)$, $MV(3)$ and $MV(4)$ are estimated which describe the relations between the segments S11, S12, S13 and S14 and the segments S21, S22, S23 and S24, respectively. The motion estimation is based on evaluation of candidate motion vectors for each of the segments $CMV(s,c)$, with s representing the segments and c representing the candidates per segment. For each of the candidate motion vectors $CMV(s,c)$ of the segments, a match error $ME(s,c)$ is computed. Per segment the candidate motion vector is selected with the lowest match error. This selected candidate motion vector is assigned as the motion vector $MV(s)$ for the corresponding segment.

The computation of the match errors $ME(s,c)$ according to the invention is based on the computation of a number of partial match errors $ME(s,c,b)$. The segmented image is divided into multiple blocks with mutually equal dimensions. For each of these blocks it is checked with which of the segments of the image it overlaps. Based on the overlap, the appropriate candidate motion vectors are selected. On basis of the candidate motion vectors and the coordinates of the blocks the corresponding pixel values of the second image 102 are accessed to be compared with the pixel values of the block. In this way block-by-block, e.g. in a row scanning scheme or column scanning scheme, the partial match errors $ME(s,c,b)$ are computed. Optionally, parallel processing is applied to compute multiple partial match errors $ME(s,c,b)$ simultaneously. The partial match errors $ME(s,c,b)$ are accumulated per segment as specified in Equation 1:

$$ME(s,c)=\sum_{b}^{b\subset s} ME(s,c,b) \qquad (1)$$

Some of the blocks are completely comprised by one of the segments, e.g. the blocks b11, b12, b13, b21, b22, b23, b31, b32, b33 and b41 are comprised by segment S11. It will be clear that in that case the partial match errors $ME(s,c,b)$ of these blocks contribute to segment S11. However there are also blocks which correspond with multiple segments. E.g. block b14 is partly located inside segment S11 and partly located inside segment S12. There

are a number of approaches to deal with these type of blocks. These approaches will be explained below by means of examples.

The first approach is based on splitting each of the blocks that overlaps with multiple segments, into a number of groups of pixels. Fig. 2 schematically shows a detail of Fig. 1. More particular, block b24 is depicted. It is shown that this block b24 comprises a first group of pixels 202 which corresponds to segment S11 and a second group of pixels 204 which corresponds to segment S12. For the first group of pixels 202 candidate motions vectors of segment S11 have to be evaluated and for the second group of pixels 204 candidate motions vectors of segment S12 have to be evaluated. Notice that some of the candidate motion vectors of segment S11 might be equal to some of the candidate motion vectors of segment S12. However, the probability is high that there are also differences between the sets of candidate motion vectors. Hence, for the first group of pixels 202 a number of partial match errors $ME(S11,c,b24(1))$ are computed and for the second group of pixels 202 a number of partial match errors $ME(S12,c,b24(2))$ are computed. In this case the first group of pixels 202 of block $b24$ is denoted as $b24(1)$ and case the second group of pixels 204 of block $b24$ is denoted as $b24(2)$. The match errors of the various candidate motion vectors of segment S11 are computed by accumulation of the partial match errors which are partly or completely comprised by segment S11.

$$\begin{aligned}
&ME(S11,c) = \\
&ME(S11,c,b11) + ME(S11,c,b12) + ME(S11,c,b13) + ME(S11,c,b14(1)) + \\
&ME(S11,c,b21) + ME(S11,c,b22) + ME(S11,c,b23) + ME(S11,c,b24(1)) + \\
&ME(S11,c,b31) + ME(S11,c,b32) + ME(S11,c,b33) + ME(S11,c,b34(1)) + \\
&ME(S11,c,b41) + ME(S11,c,b42(1)) + ME(S11,c,b43(1)) + ME(S11,c,b44(1)) + \\
&ME(S11,c,b51(1)) + ME(S11,c,b52(1))
\end{aligned} \tag{2}$$

After the accumulation of the partial match errors, for each of the candidate motion vectors the corresponding match error is known. The candidate motion vector $MV(S11,c)$ with the lowest match error is selected as the motion vector $MV(S11)$ for the segment S11.

The second approach is also based on splitting each of the blocks that overlaps with multiple segments, into a number of groups of pixels. However, if the number of pixels of a group is less then a predetermined threshold, then no partial motion vector is computed for that group of pixels. The threshold is e.g. ½ or ¼ of the number of pixels of the block. E.g. in the example as illustrated in Fig. 1 that means that for the computation of the match errors of the candidate motion vectors of segment S1 there are no contributions of the blocks b44 and b52 if the threshold equals ¼ of the number of pixels of the block. For groups of

pixels comprising more pixels than the predetermined threshold, partial motion vectors are being computed and accumulated as described above.

In the third approach, determining which of the candidate motion vectors belong to the blocks, is based on the amount of overlap between segments and the blocks within the segmented image. That means that if a particular block is overlapped by multiple segments, then partial match errors are computed on basis of all pixels of that particular block and based on the candidate motion vectors of the segment with the largest overlap with the particular block. E.g. in the example as illustrated in Fig. 1 that means that for the computation of the match errors of the candidate motion vectors of segment S1 the following blocks fully contribute to segment S1: b14, b24 and b34. Optionally, it is tested whether the largest overlap is bigger than a predetermined threshold. That is particularly relevant in the case that a block is overlapped by more than two segments. If the largest overlap is less than a predetermined threshold then no partial match errors are computed for that block.

In the fourth approach, no partial match errors are computed at all for those blocks which overlap with multiple segments. In other words, from those blocks there are no contributions for the candidate motion vector evaluation. E.g. in the example as illustrated in Fig. 1 that means that for the computation of the match errors of the candidate motion vectors of segment S1 only the following blocks contribute: b11, b12, b13, b21, b22, b23, b31, b32, b33 and b41.

It should be noted that although Fig. 1 shows two segmented images 100 and 102, in fact only one segmentation is required. That means that the other image does not have to be segmented. That is an advantage of the method according to the invention. Because the actual computations are block-based and the optional division of blocks into groups is based on the segments of one segmented image only.

Fig. 3 schematically shows an embodiment of the motion estimation unit 300 according to the invention. The motion estimation unit 300 is provided with images, i.e. pixel values at input connector 316 and with segmentation data, e.g. a mask per image or description of contours enclosing the segments per image, at the input connector 318. The motion estimation unit 300 provides per segment a motion vector at the output connector 320. The motion estimation unit 300 is arranged to estimate motion vectors as explained in connection with Fig. 1. The motion estimation unit 300 comprises:

- a creating unit 314 for creating sets of candidate motion vectors for the respective segments of a segmented image;

- a dividing unit 304 for dividing the segmented image into a grid of blocks of pixels. The dividing unit 304 is arranged to access from the memory device 302 those pixel values which belong to a block of pixels under consideration. Alternatively, the dividing unit 304 is arranged to determine coordinates and leaves the access of pixel values on basis of the coordinates to other units of the motion estimation unit 300. The memory device 302 can be part of the motion estimation unit 300 but it might also be shared with other units or modules of the image processing apparatus, e.g. a segmentation unit 402 or an image processing unit 404 being controlled by the motion estimation unit 300;
- a determining unit 306 for determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, on basis of the segments and the locations of the blocks within the segmented image;
- a computing unit 308 for computing partial match errors for the blocks on basis of the determined candidate motion vectors and on basis of pixel values of a further image;
- a combining unit 310 for combining the partial match errors into a number of match errors per segment;
- a selecting unit 312 for selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors and for assigning the selected candidate motion vectors as the motion vectors for the respective segments.

The working of the motion estimation unit 300 is as follows. See also Fig. 1. It is assumed that the image 100 is segmented into four segments S11-S14 and that initially for each of the segments there is only one candidate motion vector. These candidate motion vectors $CMV(*,*)$ are generated by means of the creating unit 314 and provided to the determining unit 306.

The dividing unit 304 is arranged to access the memory device such that the pixel values of image 100 are accessed block by block in a scanning scheme from the left top to the right bottom, i.e. from block b11 to block b88. The dividing unit 304 provides for each block e.g. b11 the corresponding (x, y) coordinates to the determining unit 306. The determining unit 306 is arranged to determine for each of the blocks of pixels which of the candidate motion vectors belong to the blocks on basis of the coordinates and on basis of the locations of the segments.

The first block b11 is completely overlapped by the first segment S11. So, only the candidate motion vector of segment S1, $CMV(S11, C1)$, is provided to the

computing unit 308. On basis of the candidate motion vector $CMV(S11, C1)$ and on basis of the coordinates of block b11 the computing unit is arranged to access pixel values of the further image 102. Subsequently a partial match error $ME(S11, C1, b11)$ for the block is computed and provided to the combining unit 310. For the blocks b12 and b13 similar processing steps are performed resulting in partial match errors $ME(S11, C1, b12)$ and $ME(S11, C1, b13)$, respectively.

The fourth block b14 is partly overlapped by the first segment S11 and partly overlapped by the second segment S12. So, two candidate motion vectors $CMV(S11, C1)$ and $CMV(S12, C1)$ are provided to the computing unit 308. The computing unit 308 is arranged to access pixel values of the further image 102 on basis of:

- the candidate motion vectors $CMV(S11, C1)$ and $CMV(S12, C1)$;
- the segmentation data; and
- the coordinates of block b11.

Subsequently two partial match errors $ME(S11, C1, b14(1))$ and $ME(S12, C1, b14(2))$ for the two groups of pixels $b14(1)$ and $b14(2)$ of block $b14$ are computed and provided to the combining unit 310.

The above described processing steps are performed for all blocks in a similar way. After all partial match errors are computed, the match errors per segment can be established. It will be clear that the computation and accumulation of partial match errors can be done in parallel.

Then for each of the segments a new candidate motion vector is generated. Preferably, these new candidate motion vectors are derived from sets of candidates of other segments. For these new candidates also the corresponding match errors are computed. After all match errors of the candidate motion vectors have been computed, the selecting unit 312 selects per segment the candidate motion vector with the lowest match error.

Above it is described that the generation and evaluation of candidate motion vectors are performed alternatingly. Alternatively, the generation and evaluation are performed subsequently, i.e. first all candidate motion vectors are generated and then evaluated. Alternatively, first a portion of candidate motion vectors is generated and evaluated and after that a second portion of candidate motion vectors is generated and evaluated.

Above it is described that for a particular block only one candidate motion vector per overlapping segment is evaluated. After that a next block is being processed.

Alternatively, all available candidate motion vectors for a particular block are evaluated and subsequently all available candidate motion vectors for a next block are evaluated.

The creating unit 314, the dividing unit 304, the determining unit 306, the computing unit 308, the combining unit 310 and the selecting unit 312 may be implemented using one processor. Normally, these functions are performed under control of a software program product. During execution, normally the software program product is loaded into a memory, like a RAM, and executed from there. The program may be loaded from a background memory, like a ROM, hard disk, or magnetically and/or optical storage, or may be loaded via a network like Internet. Optionally an application specific integrated circuit provides the disclosed functionality.

Above it is described that the processing is performed in a scanning scheme, row-by-row. Alternatively the processing is performed in parallel for a number of rows simultaneously.

Fig. 4 schematically shows an image processing apparatus according to the invention, comprising:

- A segmentation unit 402 for segmenting input images into a segmented images. The segmentation unit 402 is arranged to receive a signal representing the input images. The signal may be a broadcast signal received via an antenna or cable but may also be a signal from a storage device like a VCR (Video Cassette Recorder) or Digital Versatile Disk (DVD). The signal is provided at the input connector 410;
- The segment-based motion estimation unit 408 as described in connection with Fig. 3;
- An image processing unit 404 being controlled by the motion estimation unit 408. The image processing unit 404 might support one or more of the following types of image processing: video compression, de-interlacing, image rate conversion, or temporal noise reduction.
- A display device 406 for displaying the output images of the image processing unit 404.

The image processing apparatus 400 might e.g. be a TV. Alternatively the image processing apparatus 400 does not comprise the optional display device 406 but provides the output images to an apparatus that does comprise a display device 406. Then the image processing apparatus 400 might be e.g. a set top box, a satellite-tuner, a VCR player, a DVD player or recorder. Optionally the image processing apparatus 400 comprises storage means, like a

hard-disk or means for storage on removable media, e.g. optical disks. The image processing apparatus 400 might also be a system being applied by a film-studio or broadcaster.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention and that those skilled in the art will be able to design alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be constructed as limiting the claim. The word 'comprising' does not exclude the presence of elements or steps not listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention can be implemented by means of hardware comprising several distinct elements and by means of a suitable programmed computer. In the unit claims enumerating several means, several of these means can be embodied by one and the same item of hardware.

CLAIMS:

1. A method of segment-based motion estimation to determine motion vectors for respective segments of a segmented image, the method comprising:

- creating sets of candidate motion vectors for the respective segments;
- dividing the segmented image into a grid of blocks of pixels;
- determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, on basis of the segments and the locations of the blocks within the segmented image;
- computing partial match errors for the blocks on basis of the determined candidate motion vectors and on basis of pixel values of a further image;
- combining the partial match errors into a number of match errors per segment;
- selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors; and
- assigning the selected candidate motion vectors as the motion vectors for the respective segments.

2. A method of segment-based motion estimation as claimed in claim 1, further comprising:

- splitting each block of a portion of the blocks into respective groups of pixels on basis of the segments and the locations of the blocks within the segmented image, each block of the portion of the blocks overlapping with multiple segments;
- determining for the groups of pixels which of the candidate motion vectors belong to the groups of pixels, on basis of the segments and the locations of the groups of pixels within the segmented image;
- computing further partial match errors for the groups of pixels on basis of the determined candidate motion vectors and on basis of the pixel values of the further image; and
- combining the partial match errors and the further partial match errors into a number of match errors per segment.

3. A method of segment-based motion estimation as claimed in claim 1, whereby determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, is based on the amount of overlap between segments and the blocks within the segmented image.

4. A method of segment-based motion estimation as claimed in claim 1, whereby a first one of the partial match errors corresponds with the sum of differences between pixel values of the segmented image and further pixel values of the further image.

5. A method of segment-based motion estimation as claimed in claim 1, whereby a first one of the blocks of pixels comprises 8*8 or 16*16 pixels.

6. A motion estimation unit for estimating motion vectors for respective segments of a segmented image, the motion estimation unit comprising:

- creating means for creating sets of candidate motion vectors for the respective segments;
- dividing means for dividing the segmented image into a grid of blocks of pixels;
- determining means for determining for the blocks of pixels which of the candidate motion vectors belong to the blocks, on basis of the segments and the locations of the blocks within the segmented image;
- computing means for computing partial match errors for the blocks on basis of the determined candidate motion vectors and on basis of pixel values of a further image;
- combining means for combining the partial match errors into a number of match errors per segment;
- selecting means for selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors; and
- assigning means for assigning the selected candidate motion vectors as the motion vectors for the respective segments.

7. An image processing apparatus comprising:

- a segmentation unit for segmenting an input image into a segmented image; and

- a motion estimation unit for estimating motion vectors for respective segments of the segmented image, as claimed in claim 6.

8. An image processing apparatus as claimed in claim 7, characterized in further comprising processing means being controlled on basis of the motion vectors.

9. An image processing apparatus as claimed in claim 8, characterized in that the processing means are arranged to perform video compression.

10. An image processing apparatus as claimed in claim 8, characterized in that the processing means are arranged to perform de-interlacing.

11. An image processing apparatus as claimed in claim 8, characterized in that the processing means are arranged to perform image rate conversion.

12. An image processing apparatus as claimed in claim 7, characterized in that it is a TV.

ABSTRACT:

A method to determine motion vectors for respective segments (S11-S14) of a segmented image (100) comprises: creating sets of candidate motion vectors for the respective segments (S11-S14); dividing the segmented image (100) into a grid of blocks (b11-b88) of pixels; determining for the blocks (b11-b88) of pixels which of the candidate motion vectors belong to the blocks (b11-b88), on basis of the segments (S11-S14) and the locations of the blocks (b11-b88) within the segmented image (100); computing partial match errors for the blocks (b11-b88) on basis of the determined candidate motion vectors and on basis of pixel values of a further image (102); combining the partial match errors into a number of match errors per segment; selecting for each of the sets of candidate motion vectors respective candidate motion vectors on basis of the match errors; and assigning the selected candidate motion vectors as the motion vectors for the respective segments (S11-S14).

Fig. 1

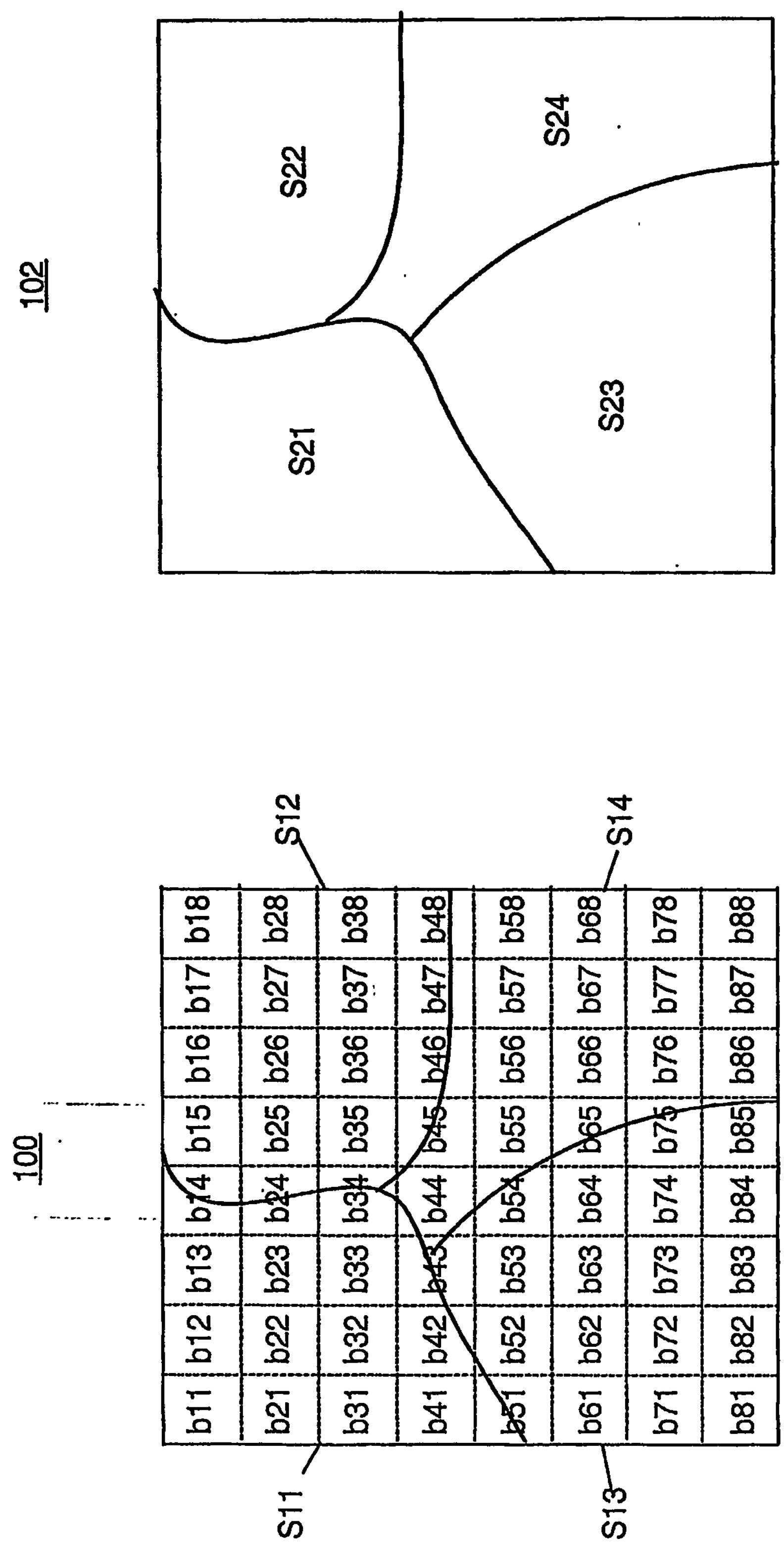
102
S22
S24
S21
S23
100
S12
S14
S11
S13
b11 b12 b13 b14 b15 b16 b17 b18
b21 b22 b23 b24 b25 b26 b27 b28
b31 b32 b33 b34 b35 b36 b37 b38
b41 b42 b43 b44 b45 b46 b47 b48
b51 b52 b53 b54 b55 b56 b57 b58
b61 b62 b63 b64 b65 b66 b67 b68
b71 b72 b73 b74 b75 b76 b77 b78
b81 b82 b83 b84 b85 b86 b87 b88

FIG. 1

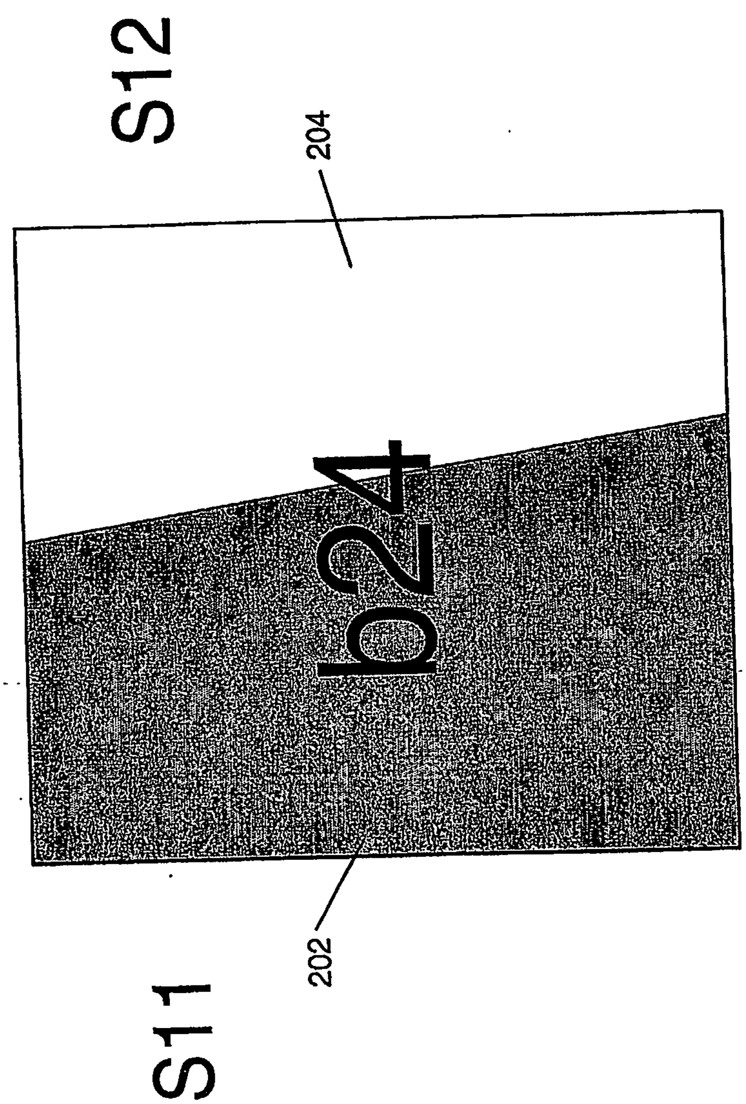

FIG. 2

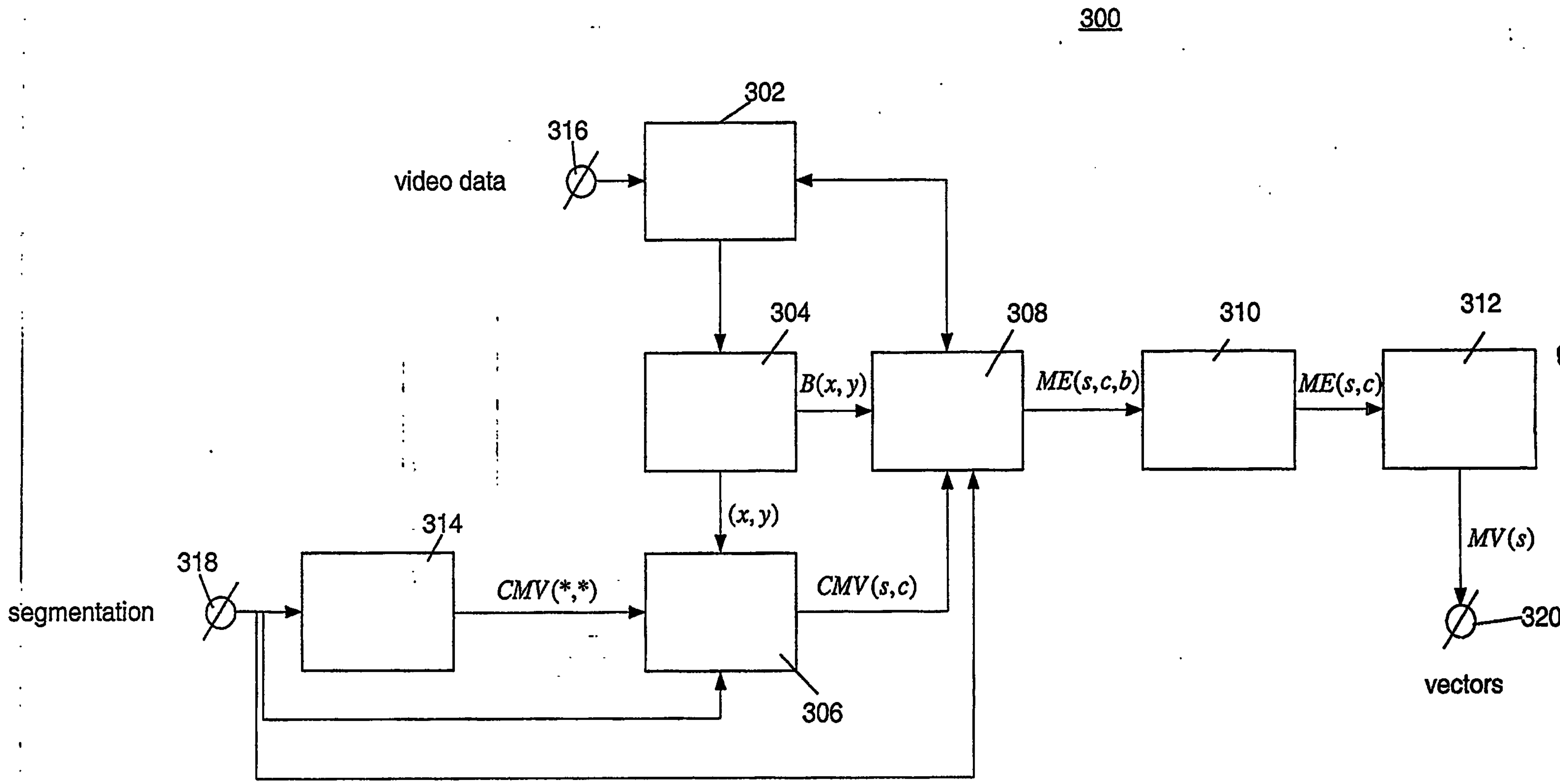
300
302
316
video data
304
308
310
312
B(x, y)
ME(s,c,b)
ME(s,c)
(x, y)
314
318
segmentation
CMV(*,*)
CMV(s,c)
306
MV(s)
320
vectors

FIG. 3

400

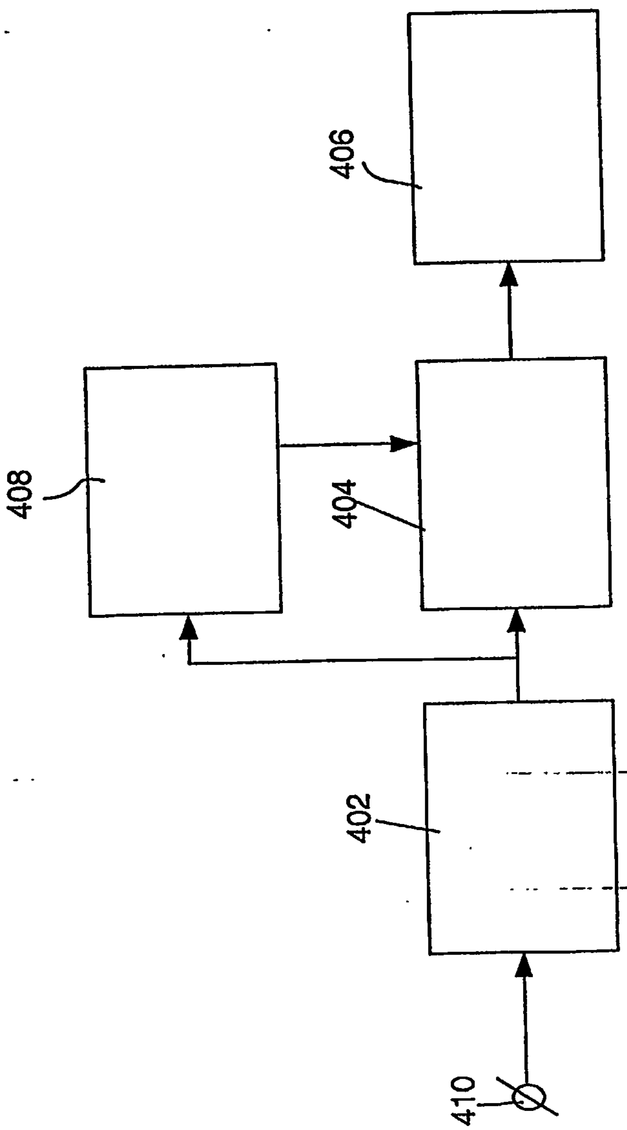

FIG. 4